Appendix E

Mitigation in Puerto Rico

Mitigation Initiatives Prior to Hurricane Georges

FEMA has been involved in ongoing hazard mitigation efforts in Puerto Rico. Trained mitigation experts from the FEMA Caribbean Office in San Juan provide educational programs, floodplain mapping, and other technical expertise. These activities include:

- **Hurricane Mitigation Guide:** This guide was developed and published in Spanish through the Institute of Engineers and Surveyors. The Hurricane Mitigation Guide is the first in a series of publications that will also include Earthquake/Tsunami and Flood/Landslide mitigation guides.
- **Children's Coloring Book:** The coloring book explains multihazard mitigation and has been distributed to school children throughout Puerto Rico.
- **Hurricane Mitigation Video:** A video discussing hurricanes and mitigation was produced in conjunction with the Puerto Rico Civil Defense and the School of Engineering in Mayaguez.
- **Storm Shutters:** An ongoing HMGP project will lead to the development of better storm shutters by testing different installation methods and evaluating impact resistant materials.

Two major mapping efforts for Puerto Rico are currently underway:

- **Coastal Restudy:** In conjunction with the University of Puerto Rico, FEMA has prepared a comprehensive restudy of coastal flood hazards for the entire shoreline of Puerto Rico. The adoption of revised Flood Insurance Rate Maps (FIRM) based on this study is expected in 1999.
- **Riverine Restudy:** FEMA is currently developing revised hydrologic and hydraulic analyses for five river basins. This study supports flood mitigation efforts in response to Hurricane Hortense and includes the Rio Cuomo, Rio La Plata, Rio Guamani, Rio Nigua, and Rio Bayamon river basins. The results of the study will be used in conjunction with Geographic Information System data supplied by the PRPB to revise the Flood Insurance Study and FIRM along the affected watersheds.

Community Action to Prevent Future Losses

Mitigating future losses will be accomplished only as a result of communities deciding that they will protect themselves, and their children, grandchildren, and businesses from future disasters. These decisions will be made as each damaged building is repaired, as each destroyed building is rebuilt, and as each undamaged building is retrofitted to avoid future losses.

Some of the steps communities can take include:

- designing buildings to modern building codes;
- ensuring new buildings are permitted, built, and inspected to meet modern codes;
- upgrading the electrical power system so power can be restored more quickly and critical services such as water and sewage systems are less likely to be disrupted;
- retrofitting existing buildings so roofs stay intact during hurricanes and earthquakes;
- avoiding the development of areas at high risk from hazards and taking special precautions for buildings already in such areas; and
- working with the private insurance industry to provide training to the public about flood insurance and its financial protection to homeowners, renters, and businessowners.

Examples of mitigation successes are presented below to illustrate previous mitigation efforts that proved beneficial in reducing losses from Hurricane Georges.

Mitigation Success Stories Following Hurricane Georges

Property Acquisition

In Ponce, Puerto Rico, FEMA and the Government of Puerto Rico worked together to acquire 88 properties in the Cerro St. Thomas neighborhood of the city. These structures, besides being heavily damaged by flooding in Hurricane Hugo, were also identified as high-landslide-risk properties. As a result of this $1.5 million total investment, residents of these properties were moved out of harm's way to where their lives and property were no longer at risk, and no further damage occurred during Hurricane Georges. In addition, the landslides that have occurred since the acquisition of the properties did not result in the loss of life or property experienced previously.

Retrofitting of Schools

FEMA provided approximately $2.5 million to retrofit more than 1,600 schools after Hurricane Hugo. This means over three-quarters of the schools in Puerto Rico have been retrofitted against wind and seismic hazards. It is because of these mitigation measures that many of these schools were safe to use as temporary shelters, and the Governor was able to reopen the school system on Monday, September 28, 1998, just 6 days after the hurricane struck.

Flood Control Projects

In the Rio Bucana and Cerrillos River basins, which feed into Ponce, Puerto Rico's second largest city, 27 inches of rain fell on September 21. Preliminary estimates indicate that flood control projects prevented over $100 million in damages in Ponce. The successful operation of the Cerrillos Dam and the Portugues and Bucana channels accounted for most of the prevented damages. The floodwater elevation at the Cerrillos Dam rose nearly 30 feet in 15 hours. Without the Cerrillos Dam and the Portugues and Bucana channels, which were running at full capacity during the storm, floodwaters would have been 4-1/2 feet deep in downtown Ponce.

Reinforced Concrete Buildings with Concrete Roof Systems

Reinforced concrete mid- to high-rise commercial buildings experienced no structural damage.

In general, reinforced concrete residential homes with reinforced concrete roof systems did not suffer structural damage.

Reinforced concrete buildings, even those vulnerable to wind exposure (such as the one on the hill), sustained little structural damage (note metal storm shutters). Wood frame buildings with less wind exposure were severely damaged or destroyed.

Clips and Fasteners

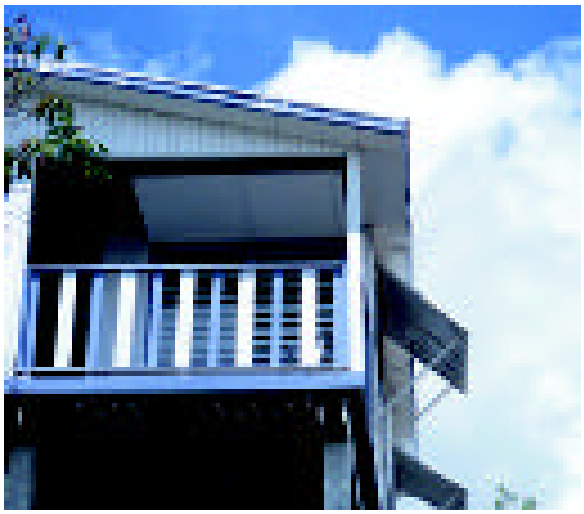
Homes on the island of Culebra that were retrofitted with hurricane clips after Hurricanes Marilyn and Hortense sustained little structural damage during Hurricane Georges.

Window Protection Systems

These windows are equipped with permanent head and sill shutter tracks that are attached to the wall with closely spaced fasteners. Residential and commercial buildings equipped with storm shutters of various designs and materials sustained little damage.

Floor Systems/Foundation Connections

A number of wood frame homes constructed after Hurricane Marilyn were designed with greater attention to load path. This is an example of a wood frame house with a floor system that adequately connects the joists and support beam to the vertical foundation column.



Some residents successfully protected their windows with wooden shutter systems. This house has hinged plywood shutters.

Roll-up shutters are another type of storm shutter system.

Appendix F

List of Acronyms

ARPE	Regulations and Permits Administration
BPAT	Building Performance Assessment Team
CDBG	Community Development Block Grant
CRP	Conservation Reserve Program
CSA	Agriculture Insurance Company
DNER	Department of Natural Environmental Resources
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
DUA	Disaster Unemployment Assistance
EDA	Economic Development Administration
EM	USDA Emergency Loans
ER	Emergency Relief
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FSA	Farm Service Agency
FTA	Federal Transit Agency
FY	Fiscal Year
HMGP	Hazard Mitigation Grant Program
HOME	HOME Investment Partnerships
HUD	Department of Housing and Urban Development
ICBO	International Conference of Building Officials
ICC	Increased Cost of Compliance
IFG	Individual and Family Grant
JTPA	Job Training Partnership Act
MRS	Minimum Road Standards
NAP	Noninsured Crop Disaster Assistance Program
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
PATH	Partnership for Advancing Technology in Housing
PREPA	Puerto Rico Electric Power Authority
PRDTPW	Puerto Rico Department of Transportation and Public Works
PRPB	Puerto Rico Planning Board
R&D	Research and Development
RBS	Rural Business Cooperative Service
RHA	Rural Housing Service
RMA	Risk Management Agency
SBA	Small Business Administration
TR	Department of the Treasury
UBC	Uniform Building Code
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture